MISR early results (albedos)

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overview

- status of MISR products
- issues with albedos
- preliminary results
- what's coming up next

MISR cloud products now provisional

- stereo heights and winds working quite well
  - current emphasis: wind QA for DAO comparisons
  - cloud heights to ≈500 m
  - height-resolved winds to ≈ 3 m s^{-1}
- can detect thin cirrus and clouds over snow/ice
  - current emphasis: dynamic thresholding
- albedos …

MISR cloud products not yet provisional

- most of the cloud classifiers
  - cloud fractions
  - angular texture indices

prerequisite challenges

- geometric calibration
  - affects stereo, especially oblique cameras
  - difficult for oceanic orbits
  - clear “winds” useful for reverse engineering
- radiometric calibration
  - known problems recently solved
  - a limiting factor for albedos

albedo issue: spatial resolution

- affects angular models
- less relevant for homogeneous scenes
  - but these are rare
- high resolution …
  - challenges multi-angle co-registration
  - re-project to a dynamic RLRA (reflecting layer reference altitude)
- low resolution …
  - clouds look more homogeneous
  - plane parallel albedo bias worsens

albedo issue: anisotropy

- use direct angular sampling
  - ok if unbiased and complete
  - ok for MISR in viewing zenith, but not azimuth
- use a theoretical model
  - corrects for known physics
  - essential that its applicability be assessed
- use a statistical/empirical model
  - assumes a stationary climate
  - lengthy development time

albedo issue: top of atmosphere

- restrictive vs expansive albedos
  - same on average
  - regional differences depend on heterogeneity
  - different values of cloud radiative forcing

other albedo issues

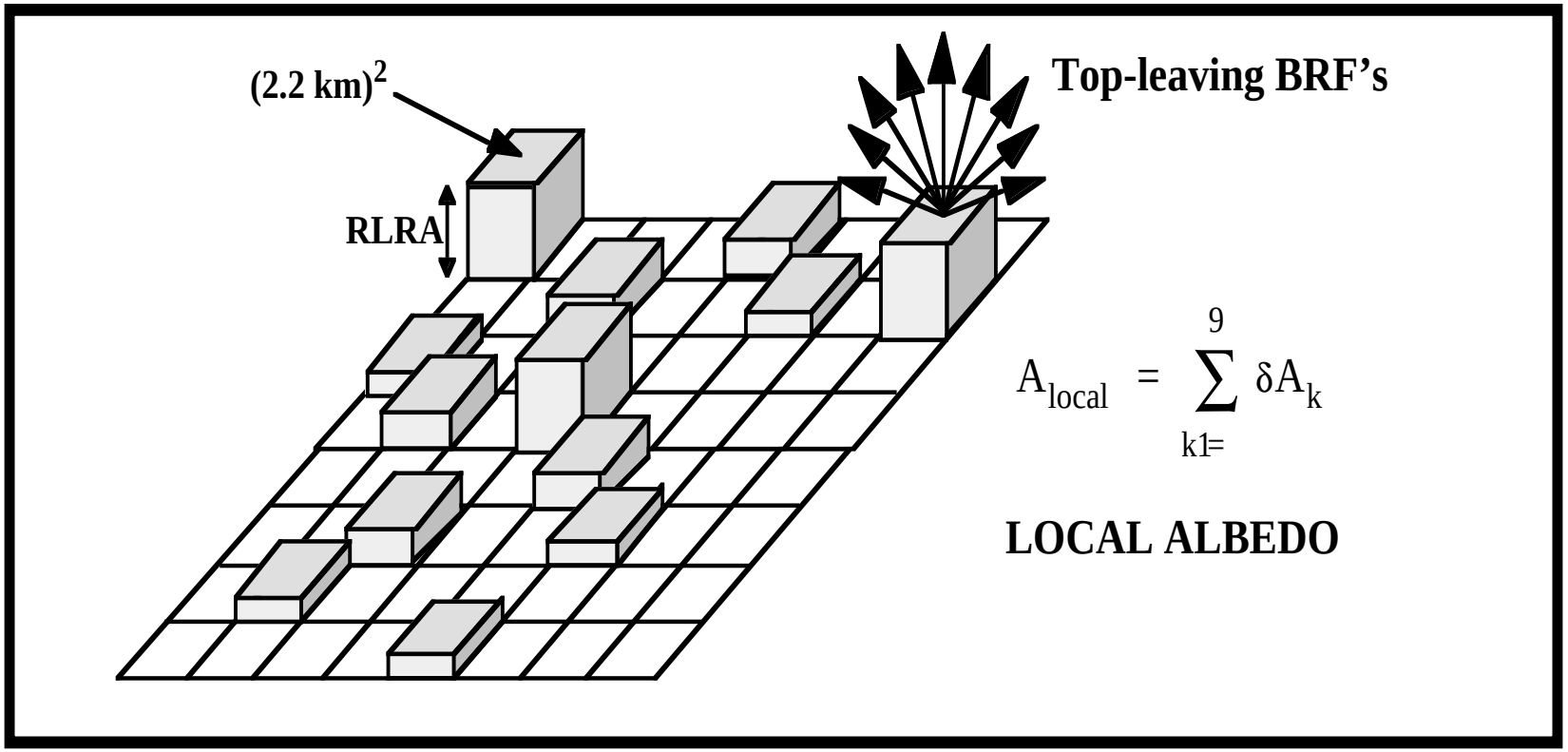
- spectral vs broadband
  - MISR produces four spectral albedos
    - 446, 558, 672, 866 nm
- sun glint
  - Kehoe's study with GOES
    - conclusive results
- limb brightening
  - Garay's study with GOES
    - inconclusive

MISR's approach

- local albedo (2.2 km)
  - requires confident RLRA
    - not provided everywhere
  - defined as unobscured component
  - to be related to cloud properties
  - provides azimuthal correction when justified
    - deterministic, stochastic or none
    - flexibly by camera

albedo calculation

- $A_{local} = \Sigma \delta a_k$
- $\delta a_k = w_k \, b_k$
- b_k are the measurements
- w_k can be chosen independently for each k based on either:
  - solid angle contribution
  - from theoretical model
  - to minimize statistical error

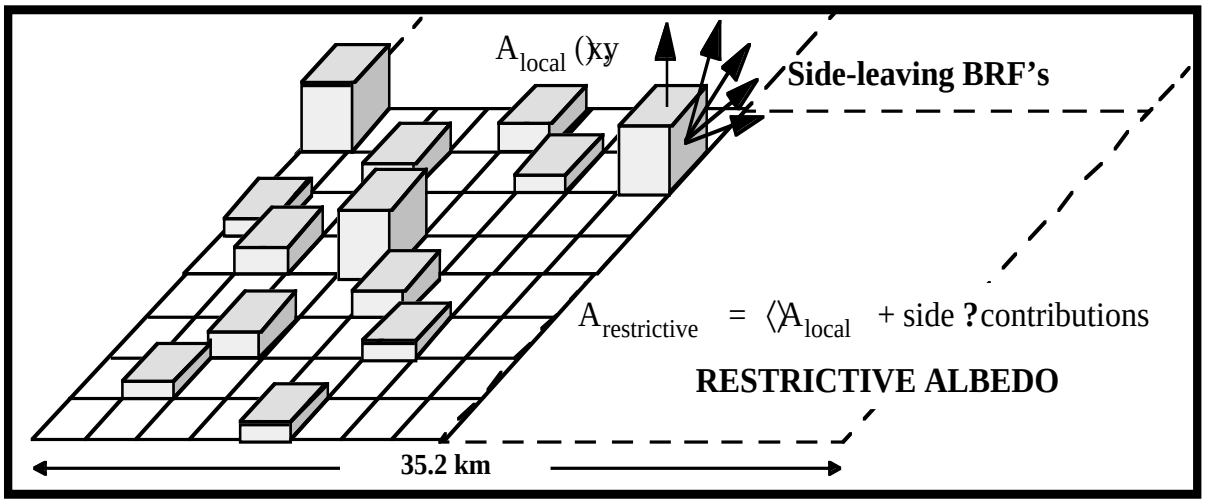

(2.2 km)2
RLRA
Top-leaving BRF's
$A_{local} = \sum_{k1=}^{9} \delta A_k$
LOCAL ALBEDO

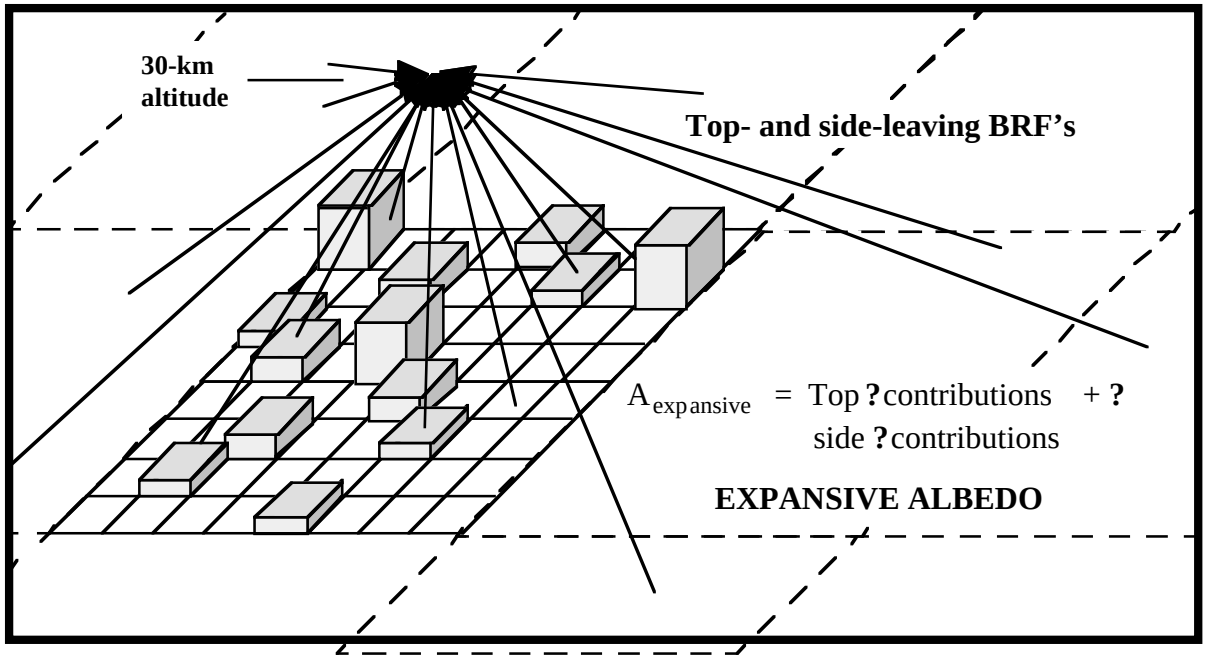
MISR's approach (cont.)

- regional (35.2 km) TOA albedos
  - provided everywhere
  - retain azimuthal corrections from local albedos
  - conserve energy over larger areas
  - defined as unobscured component

MISR's approach (cont.)

- restrictive albedo
  - sums local albedos
  - adds in missing RLRA's
  - includes effect of side-leaving radiances
- expansive albedo
  - spatial integration of measured radiances
    - entire relevant area
    - normalized to account for edge effects
    - corrected for azimuth at camera level


$A_{local}(x,y)$
Side-leaving BRF's
$A_{restrictive} = \langle A_{local} \rangle$ + side ? contributions
RESTRICTIVE ALBEDO
35.2 km

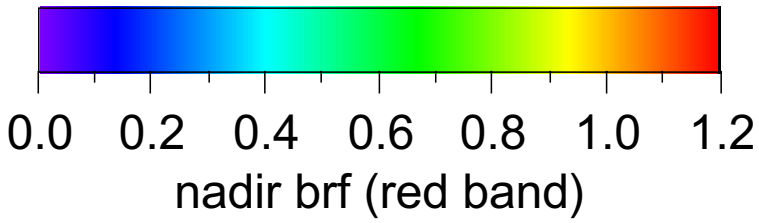

30-km altitude
Top- and side-leaving BRF's
$A_{expansive}$ = Top ? contributions + ? side ? contributions
EXPANSIVE ALBEDO

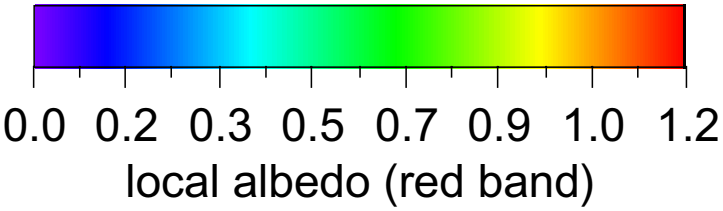
Preliminary results: local albedo

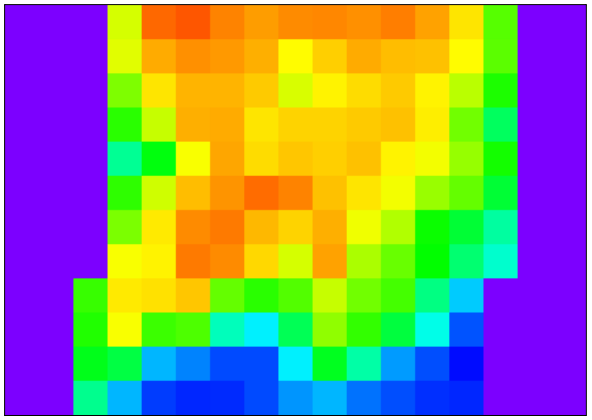
- 11-block sample of imagery
- statistical results from one orbit

orbit 11268, blocks 91-101

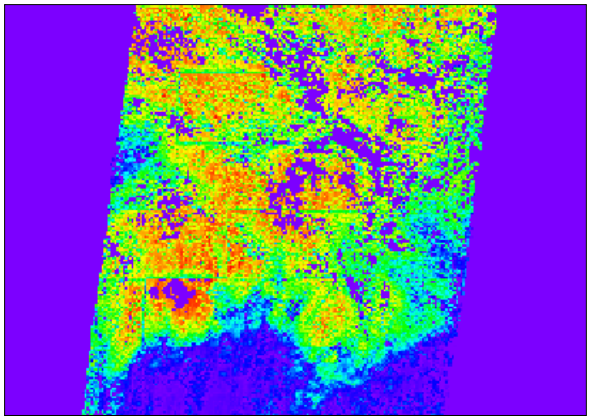
≈1500 km

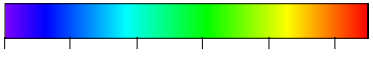


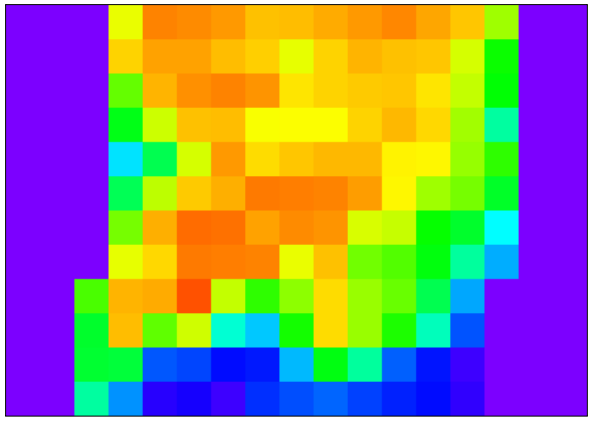


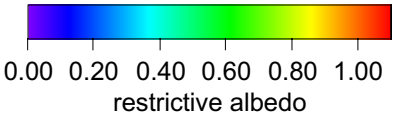


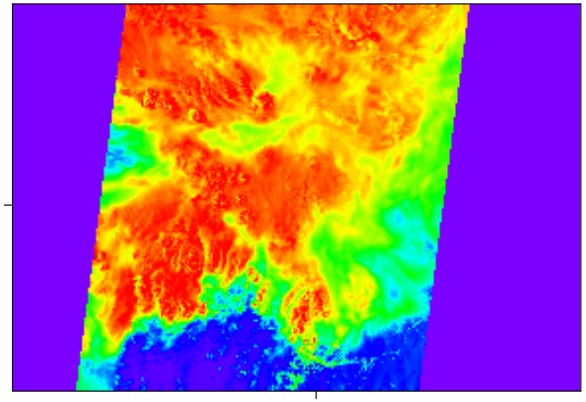

0.00 0.20 0.40 0.60 0.80 1.00
expansive albedo

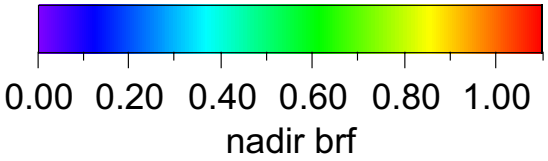


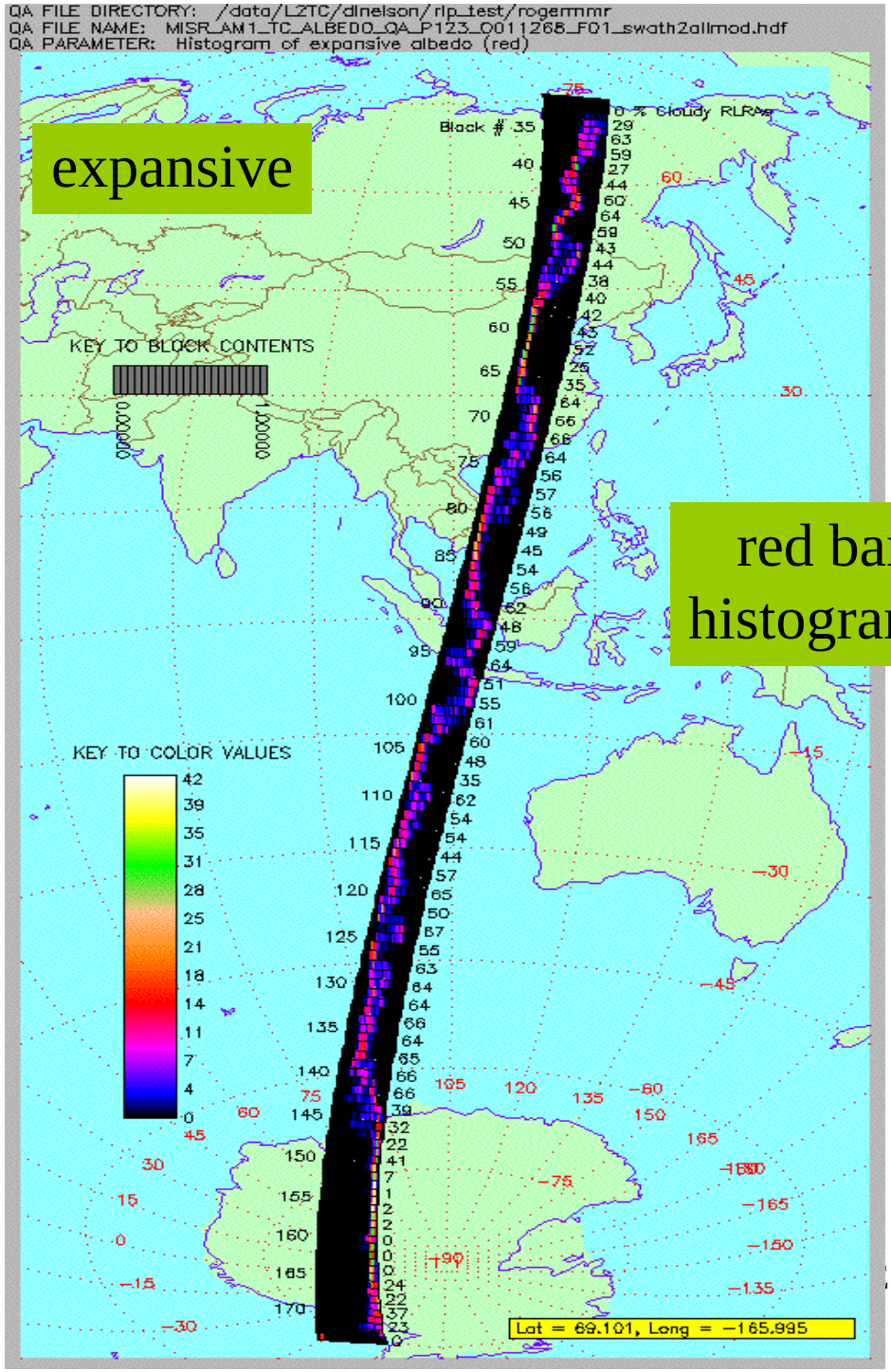

0.00 0.20 0.40 0.60 0.80 1.00
local albedo

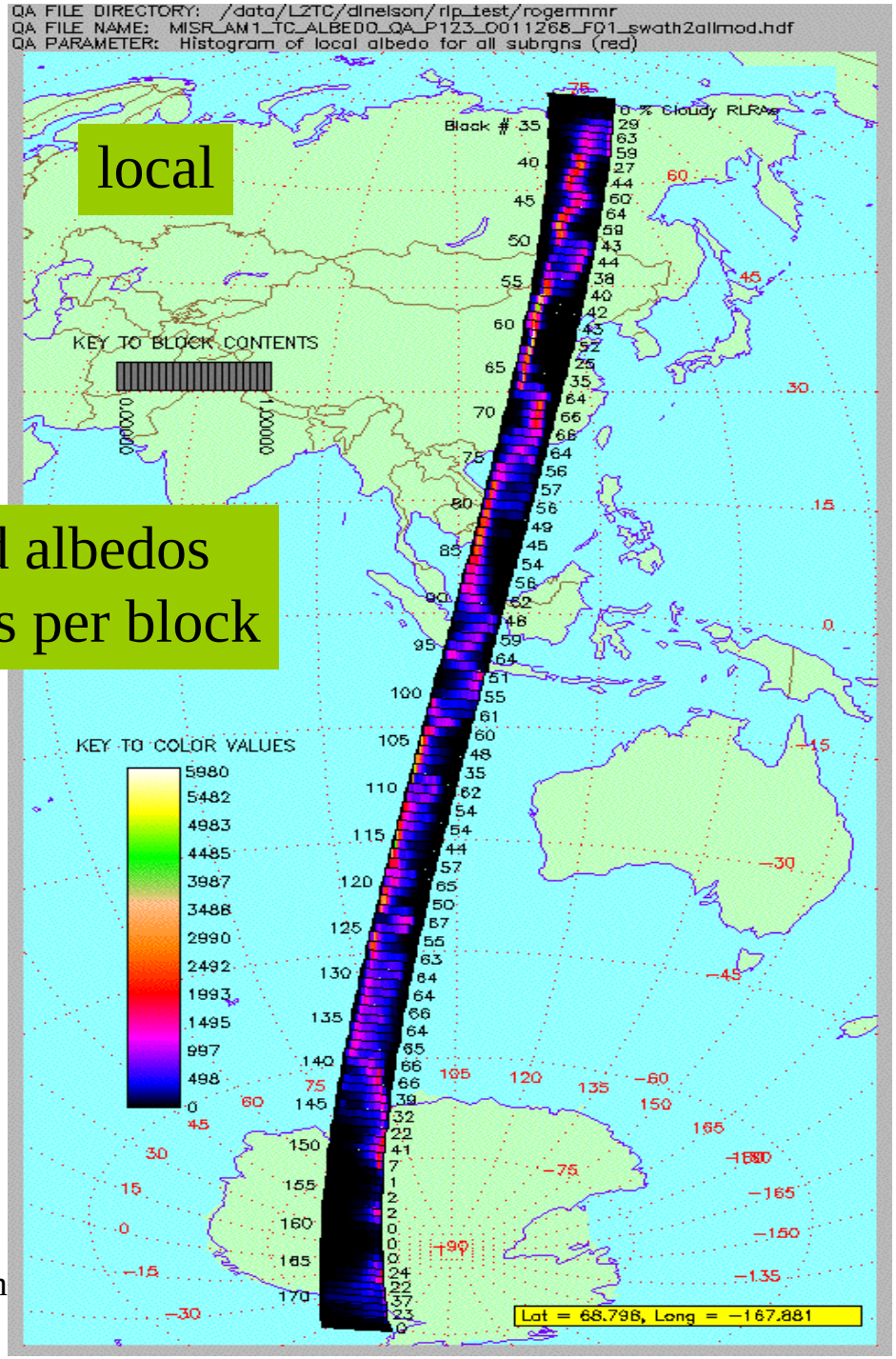



0.00 0.20 0.40 0.60 0.80 1.00
restrictive albedo




0.00 0.20 0.40 0.60 0.80 1.00
nadir brf

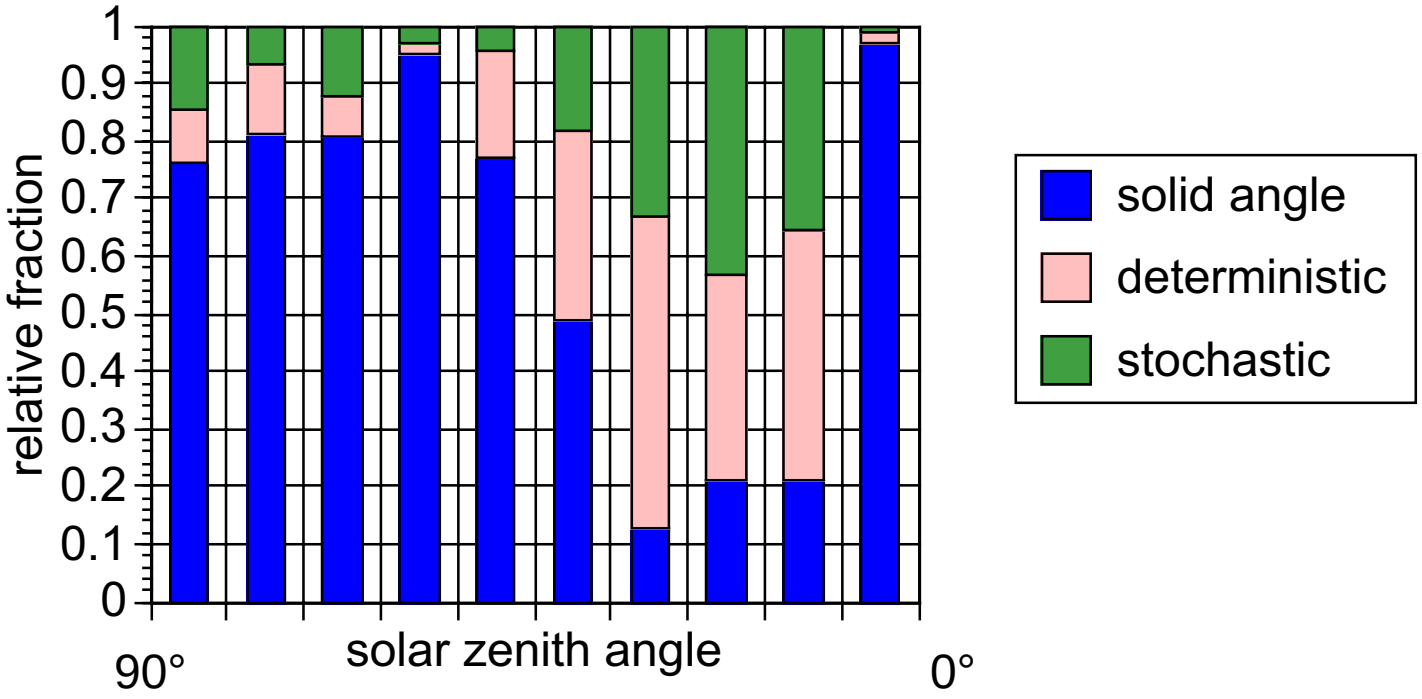




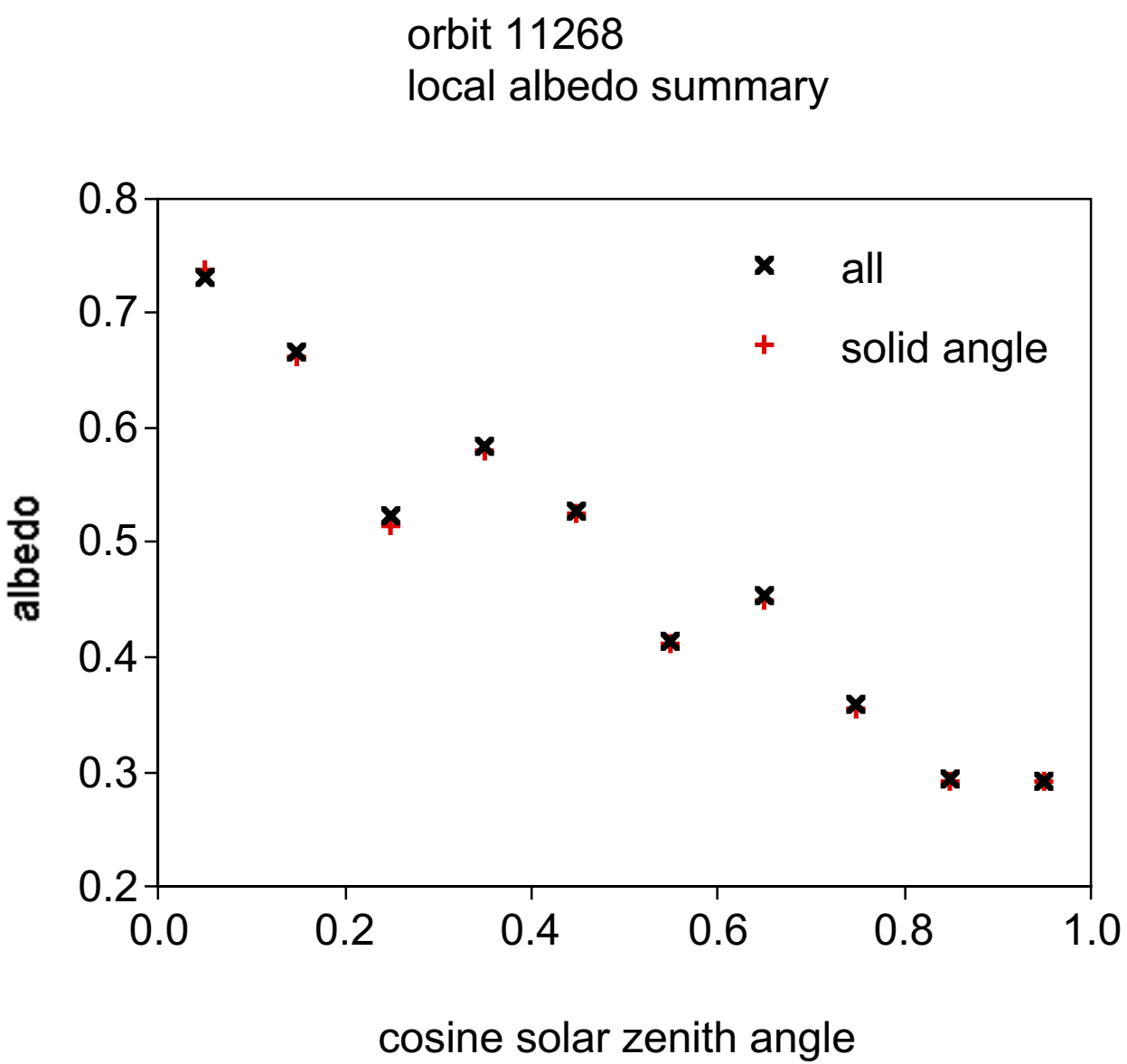
red band albedos
histograms per block

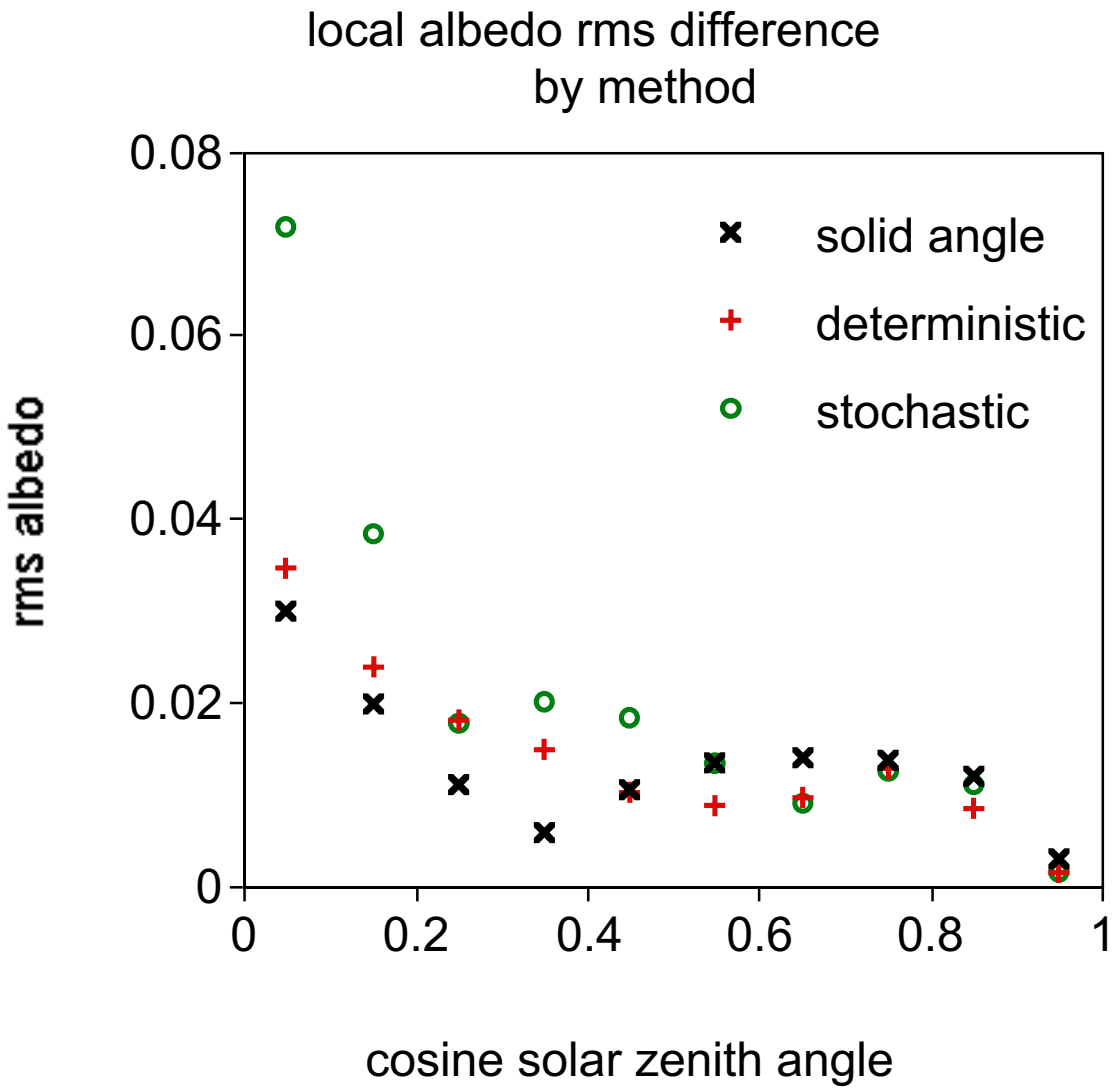
Local albedo results (one orbit)

- fraction of coverage: 60–70%
  - 30–40% of scenes either too homogeneous for stereo or too multi-layered for unique RLRA
- of this fraction:
  - ≈40% used no correction
  - ≈30% used a theoretical correction
  - ≈30% used a statistical correction



orbit 1168 summary
partitioning of azimuthal correction for local albedo

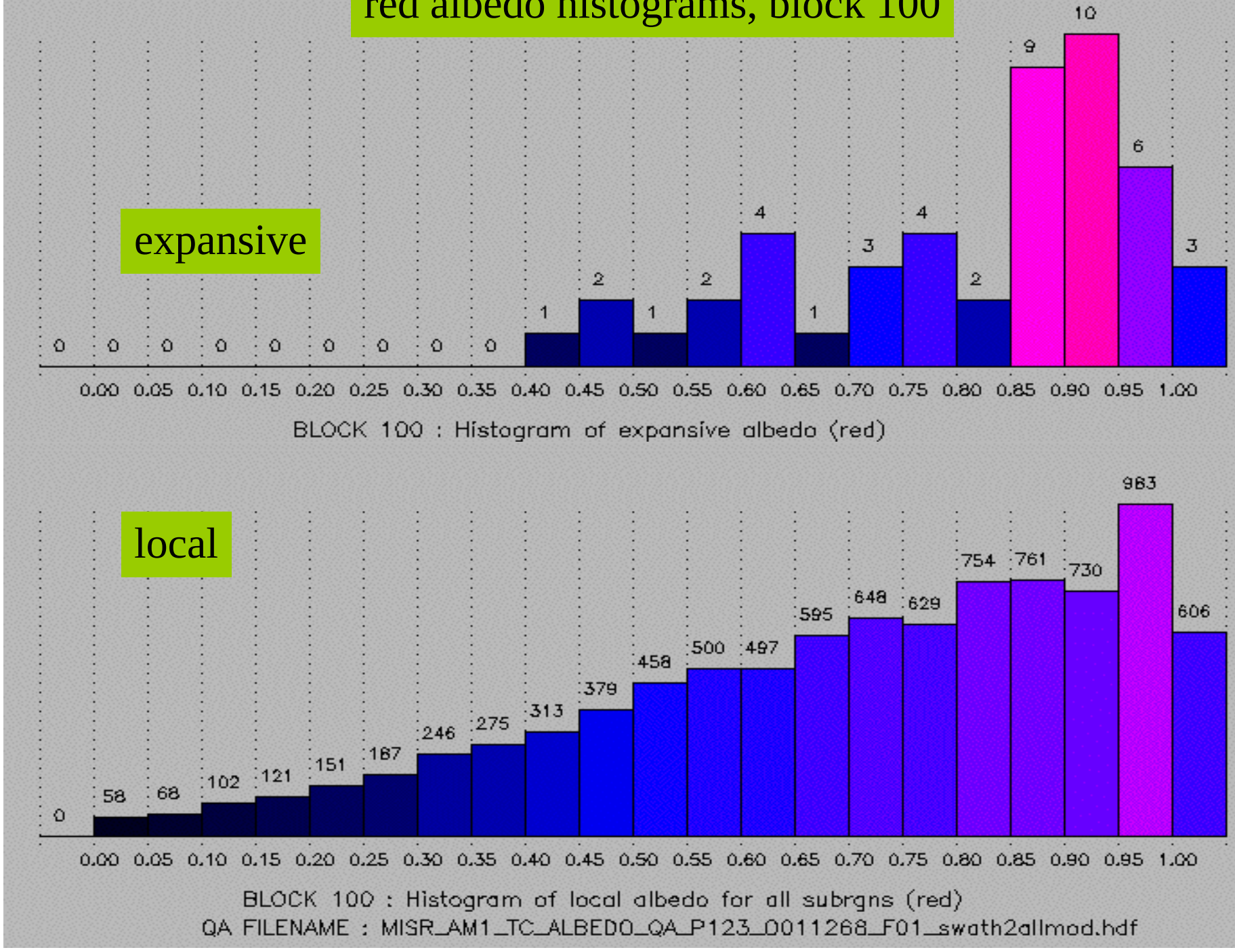

orbit 11268
local albedo summary
albedo
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.0
0.2
0.4
0.6
0.8
1.0
all
solid angle
cosine solar zenith angle


local albedo rms difference
by method
rms albedo
0.08
0.06
0.04
0.02
0
0
0.2
0.4
0.6
0.8
1
solid angle
deterministic
stochastic
cosine solar zenith angle

Blocks 90-120 RGB restrictive albedos

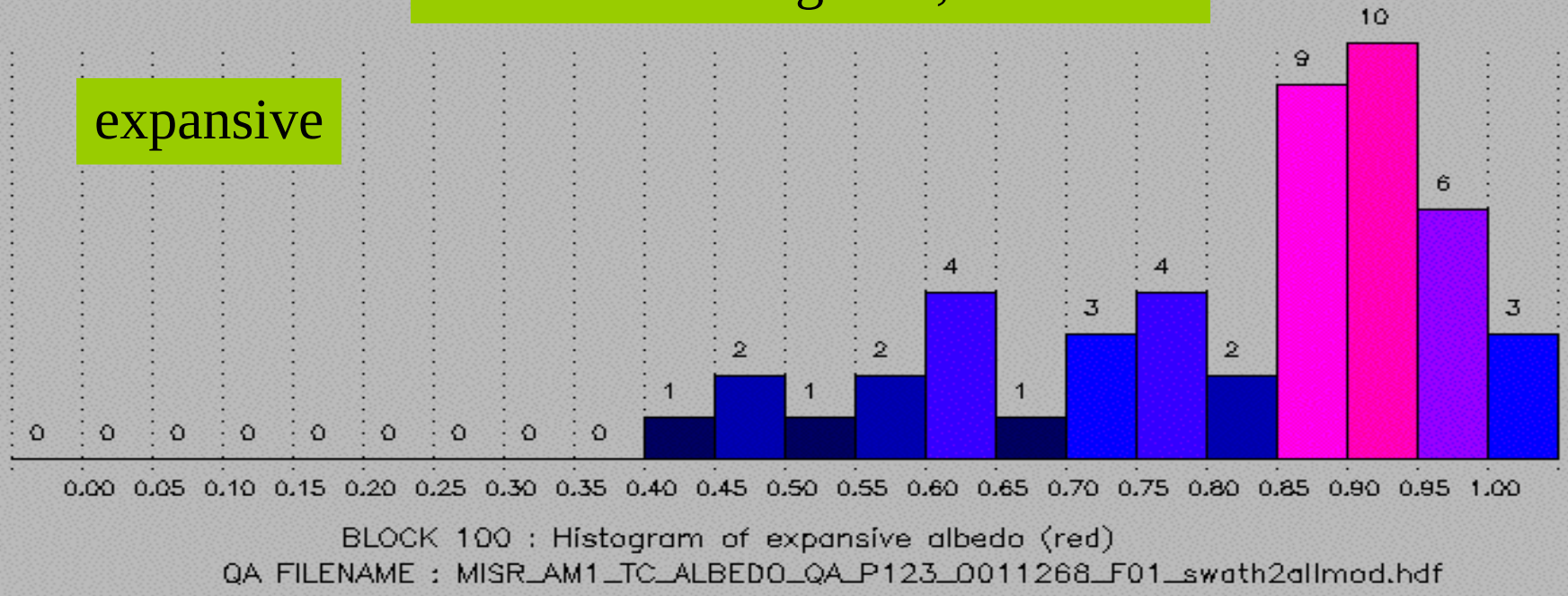
no spectral anomalies so far

red albedo histograms, block 100

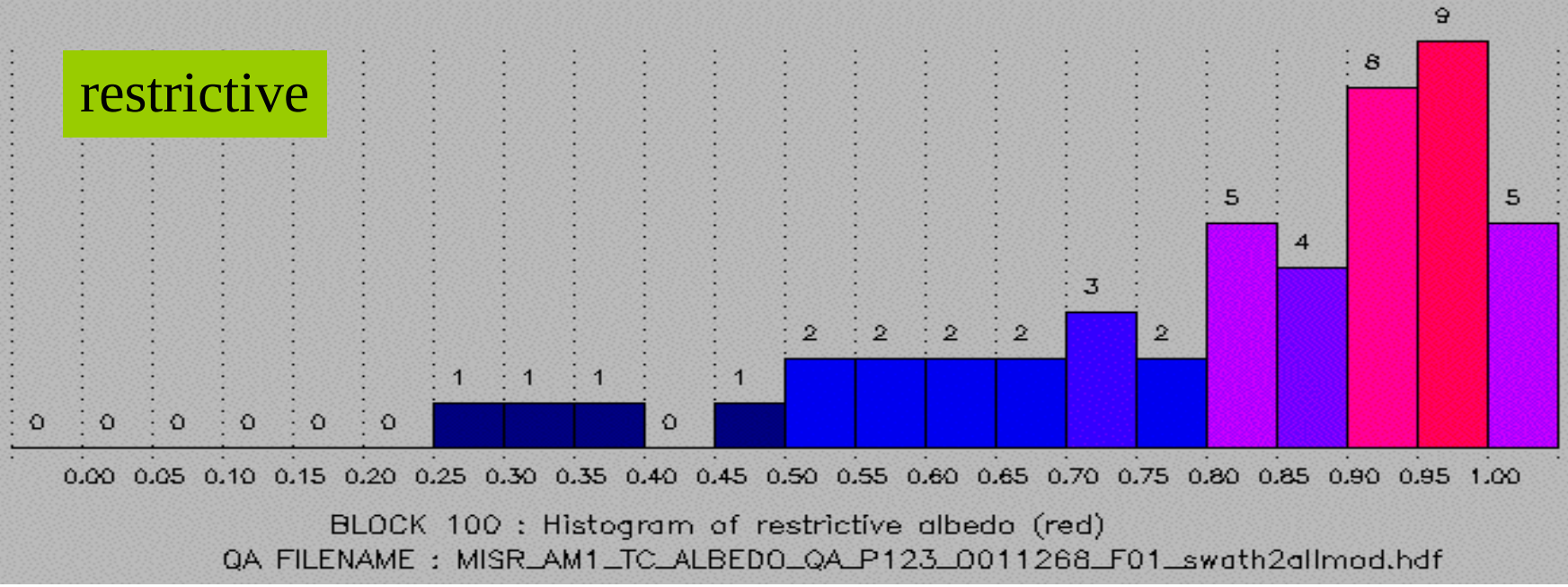


red albedo histograms, block 100

expansive

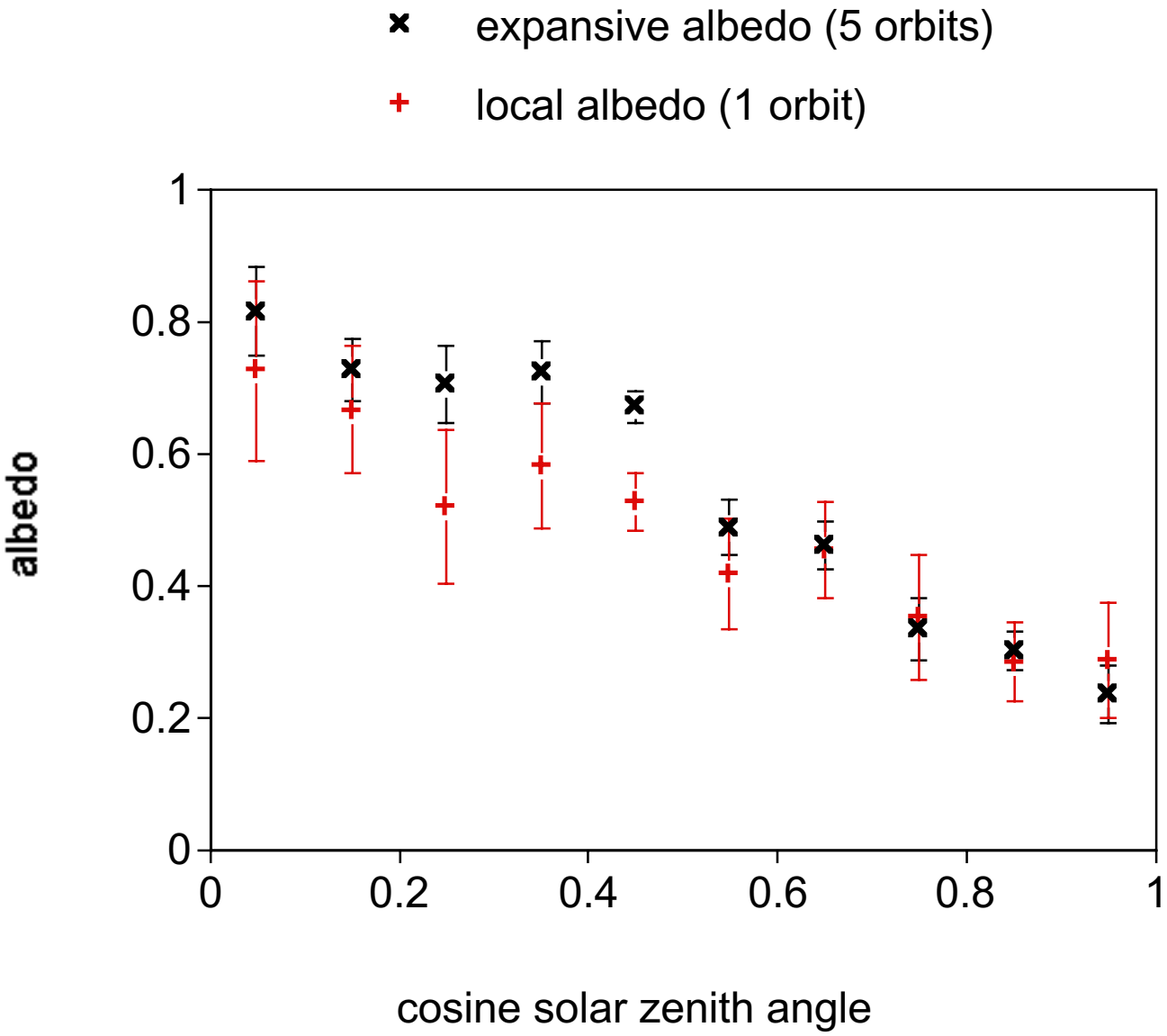


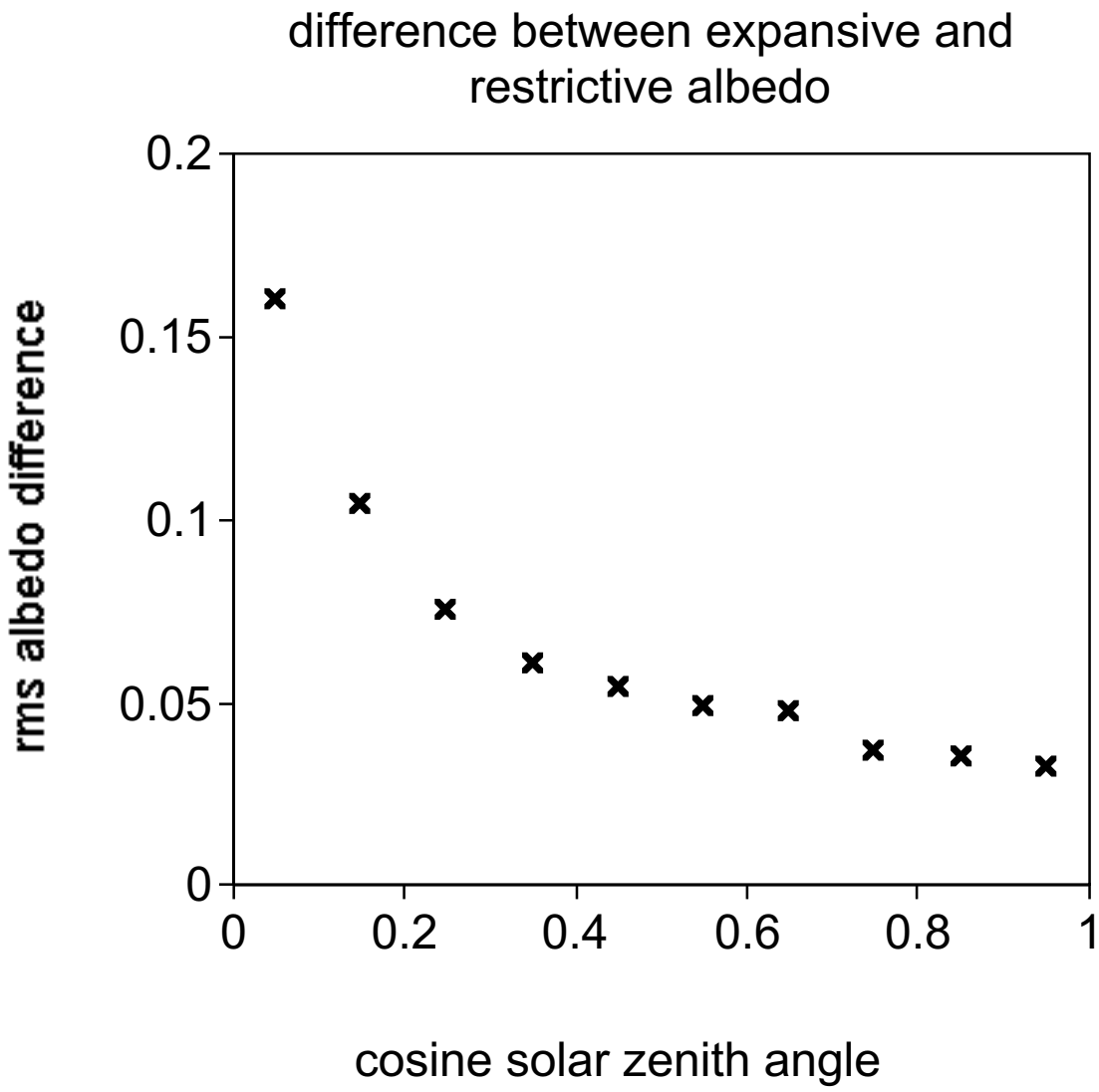
restrictive



Expansive albedos for 5 orbits

- blue:
  - 0.50 ± 0.02
- green:
  - 0.42 ± 0.02
- red:
  - 0.44 ± 0.02
- nir:
  - 0.45 ± 0.01


expansive albedo (5 orbits)
local albedo (1 orbit)
albedo
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1
cosine solar zenith angle


difference between expansive and restrictive albedo
rms albedo difference
0.2
0.15
0.1
0.05
0
0
0.2
0.4
0.6
0.8
1
cosine solar zenith angle

summary

- no obvious problems with current algorithms
- clouds working better than surface
  - implement anisotropic models for high latitude snow/ice
- ready to move on to next stage

next stage

- narrow to broadband using CERES
- comparison with CERES ADM
- development of revised stochastic weights for consistent azimuthal correction
- albedo as function of cloud properties